Federal Communications Commission

Plan for Tests of Prototype Personal/Portable TV White Space Devices

(Phase II)

Technical Research Branch
Laboratory Division
Office of Engineering and Technology
Federal Communications Commission

January 17, 2008

Prepared by Steven K. Jones and Thomas W. Phillips

INTRODUCTION

The Commission is conducting a proceeding in ET Docket No. 04-186 to consider authorizing the operation of new, low power devices in the television (TV) broadcast spectrum at locations where channels are not being used for authorized services. [1] This unused spectrum is often referred to as the "TV white spaces."

As part of this proceeding, the Office of Engineering and Technology (OET) is conducting a test program on TV white space prototype devices. The purpose of this testing program is to provide additional information for the record that will be considered in assessing the interference potential of such devices and appropriate requirements.

Initial tests (Phase I) were completed in July of 2007. [2] The Office of Engineering and Technology on October 5, 2007, issued a public notice inviting submittal of prototype devices for further tests (Phase II).[3] The Public Notice stated that further details on the testing would be released at a later time.

As part of this effort, several prototype devices were recently submitted for testing. [4] The devices are not finished consumer products. They are designed to demonstrate the feasibility of various concepts for sharing the TV broadcast spectrum without causing harmful interference. The Commission may ultimately establish requirements that the current prototype devices do not meet. However, all products would need to be certified as complying with the final rules before they may be marketed to consumers.

This document generally describes the tests that will be conducted in Phase II. The Phase II tests largely follow the procedures used for Phased I with some modifications. Comments and suggestions offered within the public record in the Commission's proceeding on the TV white spaces with respect to both the previous and current testing were considered and included where appropriate and practicable. The Phase II tests will be open to attendance and observation by any interested party.

The testing will include both laboratory (bench) tests and field tests. The laboratory tests will measure the performance capabilities of the prototype devices under controlled conditions. The field tests will be conducted at a variety of locations to provide information on the performance of the devices under real world conditions OET staff

---

[1] FCC 06-156, *First Report and Order and Further Notice of Proposed Rulemaking in the Matter of Unlicensed Operation in the TV Broadcast Bands*, ET Docket No. 04-186, October 18, 2006.

[2] OET Report FCC/OET 07-TR-1006, ***Initial Evaluation of the Performance of Prototype TV-Band White Space Devices***, S. Jones and T. Phillips, July 31, 2007.

[3] See FCC Public Notice ***The Office of Engineering and Technology announces Additional Testing of TV White Space Devices***, DA 07-4179, released October 5, 2007.

[4] See *ex-parte* filings from Adaptrum, Motorola, Philips Electronics and Microsoft, Inc. in ET Docket No. 04-186.

will adapt the test plan as appropriate based on the specific capabilities of each device and circumstances that may arise as the tests progress.

At the conclusion of the Phase II testing, a report will be issued and placed into the record in the Commission's TV white spaces proceeding. Any deviations from the test plan set forth herein will be described in this test report.

TEST PLAN

I. TELEVISION-RELATED TESTS

A. Bench Test 1 (Single Laboratory-Grade DTV Input Signal).

1. These tests will be performed to establish the minimum DTV signal level that can be detected by the WSD scanner under "best-case" (*i.e.*, non-faded DTV signal) conditions.

2. Perform single signal scanning tests with a conducted "clean" laboratory signal using the same procedures as in the Phase I effort (*i.e.*, 30 trials over a range of input signal power levels encompassing at a minimum the thresholds proposed in the proceeding as well any different threshold claimed by the manufacturer).

3. Repeat the above procedure over 3 channels in the WSD tuning range (lower, middle and upper). If the results indicate consistent performance over the three test channels, then subsequent tests will be performed on a single detection channel in the tuning range (*e.g.*, the middle channel).

B. Bench Test 2 (Single RF-Capture DTV Input Signal)

1. Repeat the single signal test procedure described above using a single RF capture from those identified in the draft IEEE 802.22 standard as the input signal rather than a clean laboratory-generated signal.[5]

2. Depending on the outcome of the tests utilizing the single laboratory-grade DTV signal, these tests are envisioned to be performed using only one detection channel.

3. This test will be repeated until all 12 of the RF captures included in the draft IEEE 802.22 standard are utilized as input signals (minimum of 12 independent tests).

[5] See ex parte submission from Qualcomm, dated August 24, 2007. Figures of the spectrum of each signal file can be obtained from:
http://grouper.ieee.org/groups/802/22/Meeting_documents/2006_May/Informal_Documents/SigPlots/

C. Bench Test 3 (Multiple DTV Signals)

1. This test is limited to two signal tests only.

2. The WSD will be subjected to a "clean" DTV signal input on a single detection channel (middle channel) that is stepped over the detection threshold range determined previously and another clean DTV signal at a high power level (-28 dBm) on a designated adjacent channel.

3. The WSD's detection capability will be tested under these conditions using the same procedures performed in the Phase I measurement effort but limited to a single detection channel.

4. These tests will be performed with the second DTV signal placed sequentially on each of the N±1 and N±2 channels relative to the test channel.

D. Bench Test 4 (Transmitter Emissions Characterization)

1. The transmitter emissions measurements are to be performed only on those prototypes submitted with transmit capability.

2. Spectral characteristics (*i.e.,* spectral signature, emissions bandwidth, out-of-band emissions and integrated channel power) will be measured and quantified.

E. Field Tests

1. The number of test sites and their locations will be decided as experience and practicality dictate. A diverse selection of sites will be chosen to represent realistic locations where personal/portable WSDs might operate in competition with over-the air (OTA) broadcast television reception. This will include a sample of personal residences (single family and multiple unit dwellings) and business structures located in urban, suburban and rural environs.

2. Preparation (performed for each test location identified)

    a. Identify test site and location (GPS coordinates).
    b. Run database search to identify and plot all licensed DTV stations with noise-limited contours that envelop the test site.
    c. Use the information to determine actual RF channel assignments and to predict the channels that should be receivable at the site and their estimated power levels.

d. If cable television service is available at test site, gather information with regard to channel assignments and their correlation to RF broadcast channels.

3. On-Site Testing

   a. Verify the stations/channels that can be received on a DTV receiver (preferably an existing system).
   b. Use existing antenna downlead and spectrum analyzer to measure the power level associated with each DTV station identified from the database (including those where service could not be verified above). If an existing rooftop antenna is not available, other methods, such as the use of a telescoping mast, will be used to perform this measurement.
   c. Operate scanner function of WSD at various locations within (and outside of) the test site and record results (if possible, this procedure will be automated to electronically record information regarding channel occupancy/availability).
      i. These tests will utilize a common laboratory-grade calibrated receive antenna with all prototype WSDs
   d. Measure a sample of the available DTV signal levels with a spectrum analyzer and a calibrated test antenna that is placed as close as possible to the location where the scanner was operated.

F. Anecdotal TV Interference Investigations

1. Two separate types of anecdotal tests of WSD transmitter interference potential will be performed as a part of this effort. In addition, at sites where cable television service is available, a separate test to evaluate direct pick-up interference will be performed to the extent that it is feasible to do so.

2. The first anecdotal test will be performed at each site at which field tests are performed using the following procedure:

   a. Tune the WSD transmitter and the television to same channel as the lowest measured (but receivable) DTV station and activate the transmitter at each measurement location while observing picture quality for degradation.
   b. Repeat this test for the highest measured DTV signal location.
   c. Repeat for adjacent channel interactions if appropriate fixed-tuned transmission filters are available (this test may be limited to co-channel interactions because of external tuned-filter limitations and availability).

3. If cable service is available at the test site, the WSD transmitter will be tuned to a receivable cable channel (this will require preliminary access to cable providers channel mapping strategy) and activated at various locations while observing the television picture quality for signs of degradation.

4. A stand-alone anecdotal interference test, similar to that performed in the initial test effort, will be performed utilizing a similar procedures as follows:

    a. Set up a test range, likely on FCC laboratory property, where the WSD distance relative to a test DTV receiver set-up can be varied in quantifiable steps.
    b. Identify an OTA DTV signal that represents the lowest receivable signal level (as close as possible to the threshold of visibility (TOV)) relative to a typical outdoor TV antenna mounted on a rooftop, or alternatively, on a telescoping mast elevated to simulate a rooftop mounted antenna.
    c. A test DTV receiver connected to the test antenna will then be tuned to the selected weak signal channel.
    d. The WSD will be tuned to the same channel and activated to represent a co-channel interaction.
    e. The WSD will be moved relative to the DTV antenna in defined steps until the maximum distance at which observable degradation to the television picture quality is observed.
    f. Optimally these tests will be repeated to demonstrate the interference potential from WSD transmissions on each of the N±1 and N±2 adjacent channels (relative to the selected DTV channel); testing for adjacent channel will depend on whether appropriate filters are available.
    g. Preliminary scans indicate that the test channel most likely to be utilized in these tests is channel 28 (WFPT-DT with broadcast tower located in Frederick, Maryland, approximately 26 miles WNW of the FCC laboratory). Testing on this channel will require external bandpass filters centered in channels 26, 27, 29 and 30 to enable testing interference interactions on all N±1 and N±2 adjacent channels.

The option to utilize band-limited additive white Gaussian noise (AWGN) will be retained as a potential method to simulate WSD emissions (in adherence to proposed emission mask); this could be used to avoid the problems associated with the external filter implementation limitations.

G. Investigation of Additional Interference Avoidance Features

We will also consider any additional features or functions that may be included in the device to facilitate interference avoidance, such as geolocation and data base access. Tests of such capabilities will be performed to the extent this may be feasible.

II. WIRELESS MICROPHONE-RELATED TESTS

The test program will use a variety of Part 74 wireless microphones from different manufacturers to examine the sensing capability and interference potential of WSDs to microphone systems. It is noted that wireless microphones employ different types of modulation and features such as tone keys. In the Phase II tests, the wireless microphone

tests will include the microphones used in the initial tests and also microphones from additional providers. These new microphones will expand the range of modulation methods and features examined.

A. Bench Tests – Sensing

1. The microphones used in these tests will be modulated with a 1000 Hz tone at 24 kHz deviation and with no modulation.

2. Tests will be performed at operating frequencies in the center of the TV channel and near the channel edges.

3. The power level of the microphones will be varied to determine the highest and lowest levels at which the WSD will reliably detect the microphone signal.

B. Bench Tests – Interference

1. Interference to wireless microphones is defined as a reduction in SINAD to 30 dB for FM microphones and a specified BER for digital microphones at -80 dBm input signal level to the receiver caused by an undesired signal with the microphone modulated with a 1000 Hz tone at 24 kHz deviation.

2. Tests will be performed with the WSD signal co-channel and on the first and second adjacent channels to the wireless microphone signal.

C. Field Tests – Sensing

1. In order to prepare for field tests at events or other venues where Part 74 wireless microphones are in actual use, simulated tests will be conducted at the Laboratory facility using the available buildings and grounds. Tests will be performed in several different scenarios to obtain a sense of what to expect at "real world" sites and to resolve any problems that are revealed that may occur at a "real world" site.

2. Based on the experience gained from the simulated tests, field tests will be performed at as yet to be determined event locations where there is extensive use of wireless microphones. Possible sites include sports arenas and theaters where a number of wireless microphones are used and broadcasting events. A variety of challenging configurations will be explored at locations with different characteristics.

D. Field Tests – Interference

1. Provided a transmitter is included in the WSD, it will also be tested to examine the potential for causing interference to wireless microphones in

simulated field scenarios at the Laboratory and the results compared to the results of tests and theoretical analyses submitted to the record in this proceeding. The methodology will be modified as necessary to yield useful and meaningful results and produce the highest confidence in the accuracy of the results. For example, assuming a typical scenario of a microphone receiver located 10 meters from the microphone, the degree of interference will be determined with the WSD at various distances from the receiver for co-channel and first and second adjacent channel operation.

2. The methodology derived from the simulated field tests will then be used to conduct actual field tests as in Section C.2 above.

TEST REPORT

At the conclusion of this test program, OET will prepare a report that sets forth the results of its Phase II tests of prototype personal/portable white space devices. This report will be inserted into the record of the Commission's proceeding in ET Docket No. 04-186 and an opportunity will be provided for interested parties to comment thereon.